Carbon Map for the National Inventory of Greenhouse Gases

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Why a carbon map is needed?

- *Basic IPCC approach to estimate emissions*

Emission = A• EF

A = activity data (e.g., deforested area)

EF = emission factor (e.g.,carbon stock in the area affected by the deforestation activity)

Why a carbon map is needed?

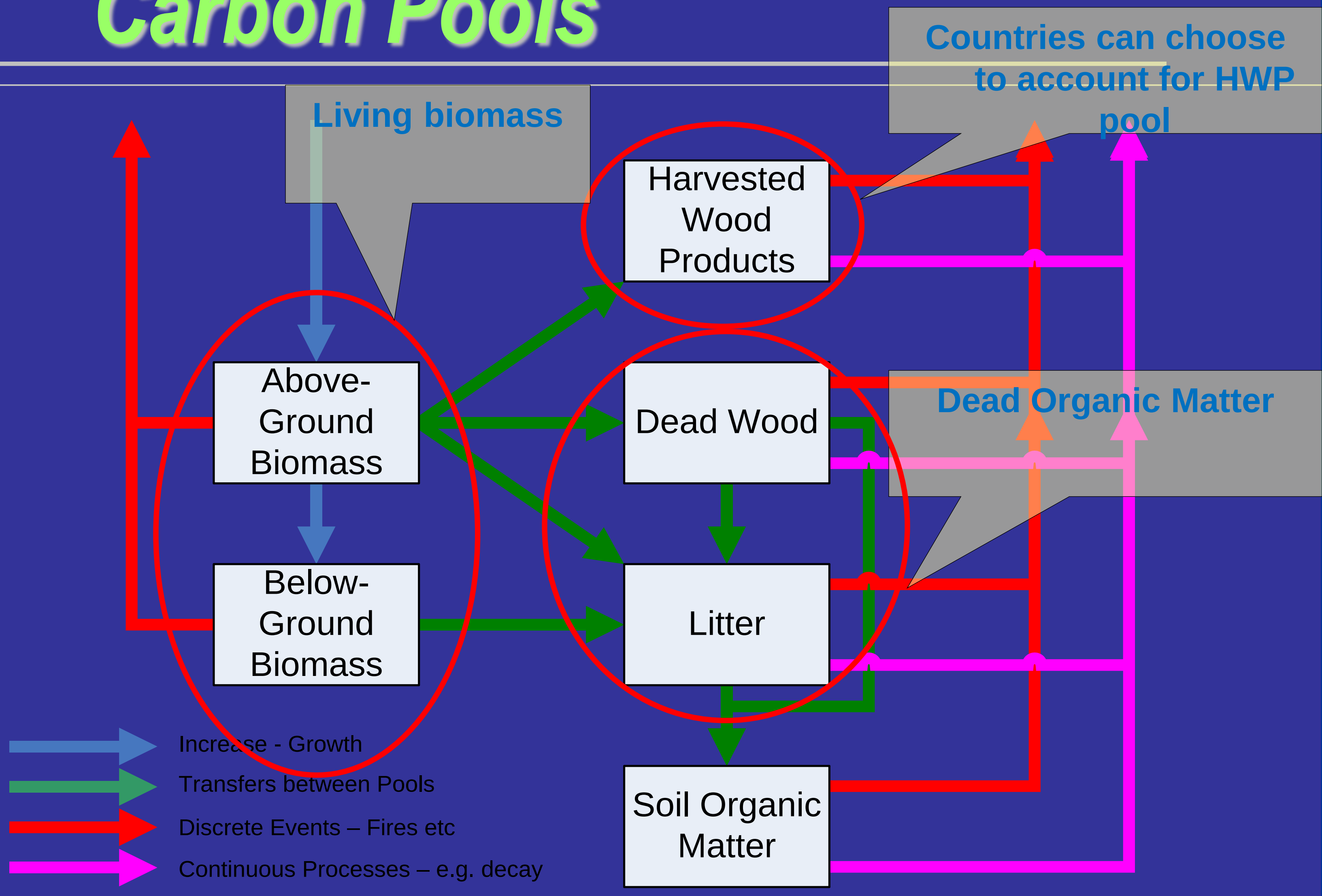
- Basic IPCC approach to estimate emissions

- Flexibility to accomodate for national circumstances
  - Tier 1 (default)
  - Tier 2 (national)
  - Tier 3 (national)

Carbon Pools

- Aboveground biomass
- Belowground biomass
- Dead Organic Matter
  - Litter
  - Dead Wood
- Soil Organic Carbon

Carbon Pools



Allometric Equation (Higuchi, 1998)

For 5 cm ≤ DBH < 20 cm

$$\ln P = -1.754 + 2.665 \times \ln DBH$$

For DBH ≥ 20 cm

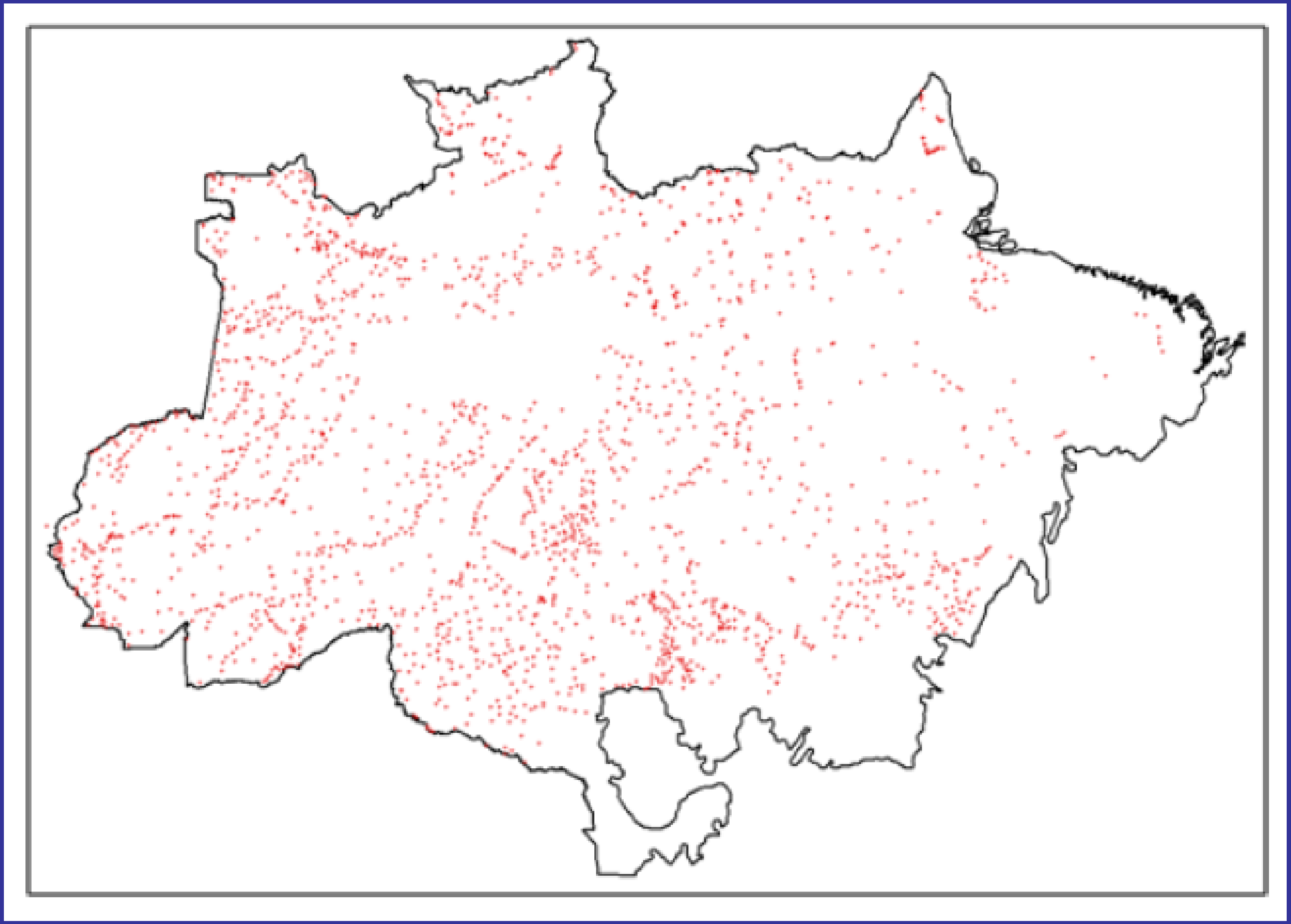
$$\ln P = -0.151 + 2.170 \times \ln DBH$$

where:

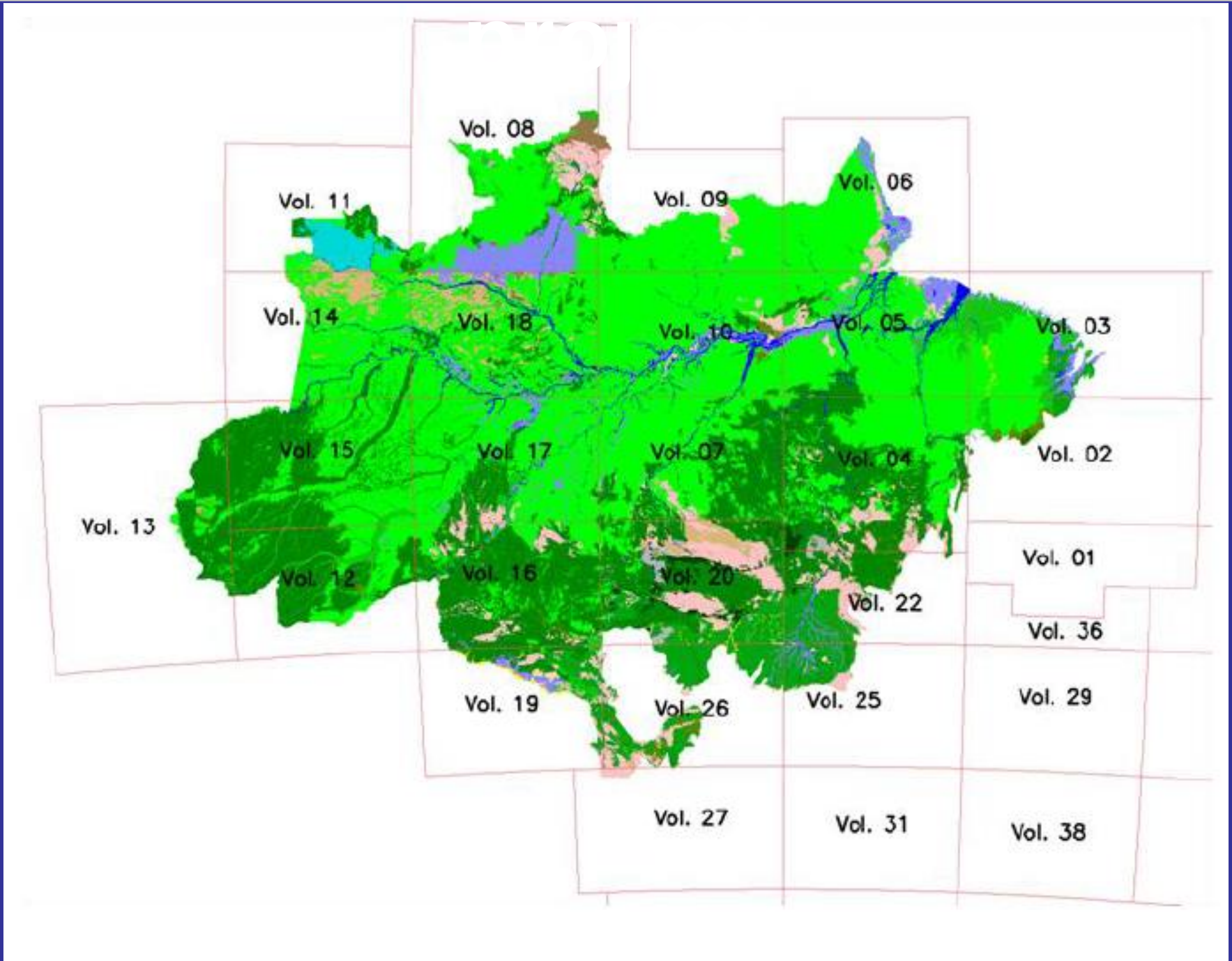
P = aboveground fresh biomass of a sampled tree; kilogram (kg of fresh biomass)

DBH = diameter at breast height of the sampled tree; centimeters (cm)

RADAMBRASIL Forest Inventory Plots



Vegetation Map from RADAMBRASIL



Carbon in Forest Types – RADAMBRASIL charts

Volume RADAMBRASIL	Fisionomia							
	Aa	Ab	As	Da	Db	Dm	Ds	La
	(tC/ha)							
2	98,24	154,55	110,06	182,98	176,10	139,03	169,35	183,00
3	98,24	154,55	129,28	137,85	161,01	139,03	275,37	183,00
4	94,88	154,55	129,28	119,67	154,59	139,03	148,30	183,00
5	108,33	154,55	146,82	213,85	185,15	109,69	230,13	183,00
6	123,75	154,55	133,99	131,82	222,39	109,69	213,55	183,00
7	159,51	160,29	180,66	142,58	153,42	139,03	175,71	262,99
8	146,97	197,91	73,64	270,89	163,92	149,50	138,56	183,00
9	127,61	213,37	112,13	262,68	157,38	109,69	184,64	262,99
10	141,81	169,49	146,45	174,03	149,54	147,77	171,21	262,99
11	154,71	197,91	158,20	166,72	168,13	83,74	144,81	114,31
12	144,32	150,69	116,14	164,35	157,42	139,03	161,84	183,00
13	144,76	144,62	139,24	168,64	153,25	104,05	121,02	160,43
14	154,71	177,28	173,89	157,86	174,17	104,05	142,46	160,43
15	172,81	164,36	156,03	171,77	154,38	104,05	155,40	228,80
16	165,70	136,14	156,76	175,73	188,14	139,03	175,02	183,00
17	136,09	159,17	157,15	175,64	165,53	104,05	159,63	228,80
18	162,92	213,37	150,61	174,79	158,01	139,03	140,48	262,99
19	150,22	147,92	135,72	170,56	159,40	139,03	154,78	183,00
20	150,61	151,80	117,97	169,39	163,05	139,03	123,29	183,00
22	148,74	154,55	97,40	137,67	153,42	139,03	145,55	183,00
25	155,84	154,55	113,12	172,77	162,51	139,03	127,87	183,00
26	165,70	136,14	130,49	175,73	188,14	139,03	153,93	183,00

	Regra 1
	Regra 2
	Regra 3

- **Aa –Alluvial Open Humid Forest**
- **Ab – Lowland Open Humid Forest**
- **As – Submontane Open Humid Forest**
- **Da – Alluvial Dense Humid Forest**
- **Db – Lowland Dense Humid Forest**
- **Dm - Montane Dense Humid Forest**
- **Ds - Submontane Dense Humid Forest**
- **La – Wooded Campinarana**

From Fresh Biomass to Carbon

$$C_{(CBH > 100\ cm)} = 0.2859 \times P$$

[water content: 0,416 (± 2.8 per cent)]

[carbon content: 0,485 (±0.9 per cent)] (Silva, 2007)

where*:*

P = aboveground fresh biomass of a sampled tree; (kg of fresh biomass)

$C_{(CBH > 100\ cm)}$ = carbon in the aboveground dry biomass of a tree with CBH>100cm; kilogram of carbon (kg of C)

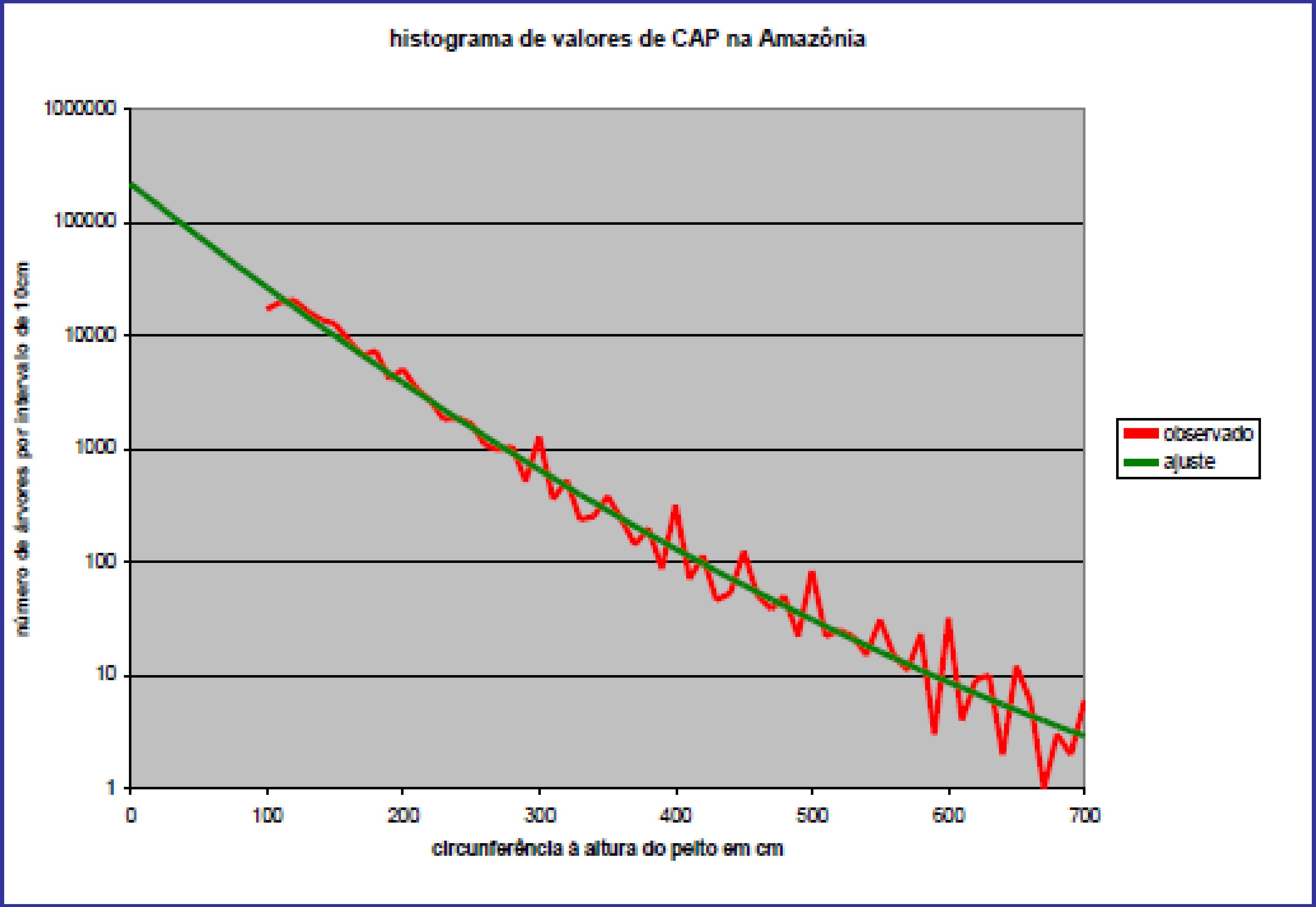
Including Carbon from all Trees

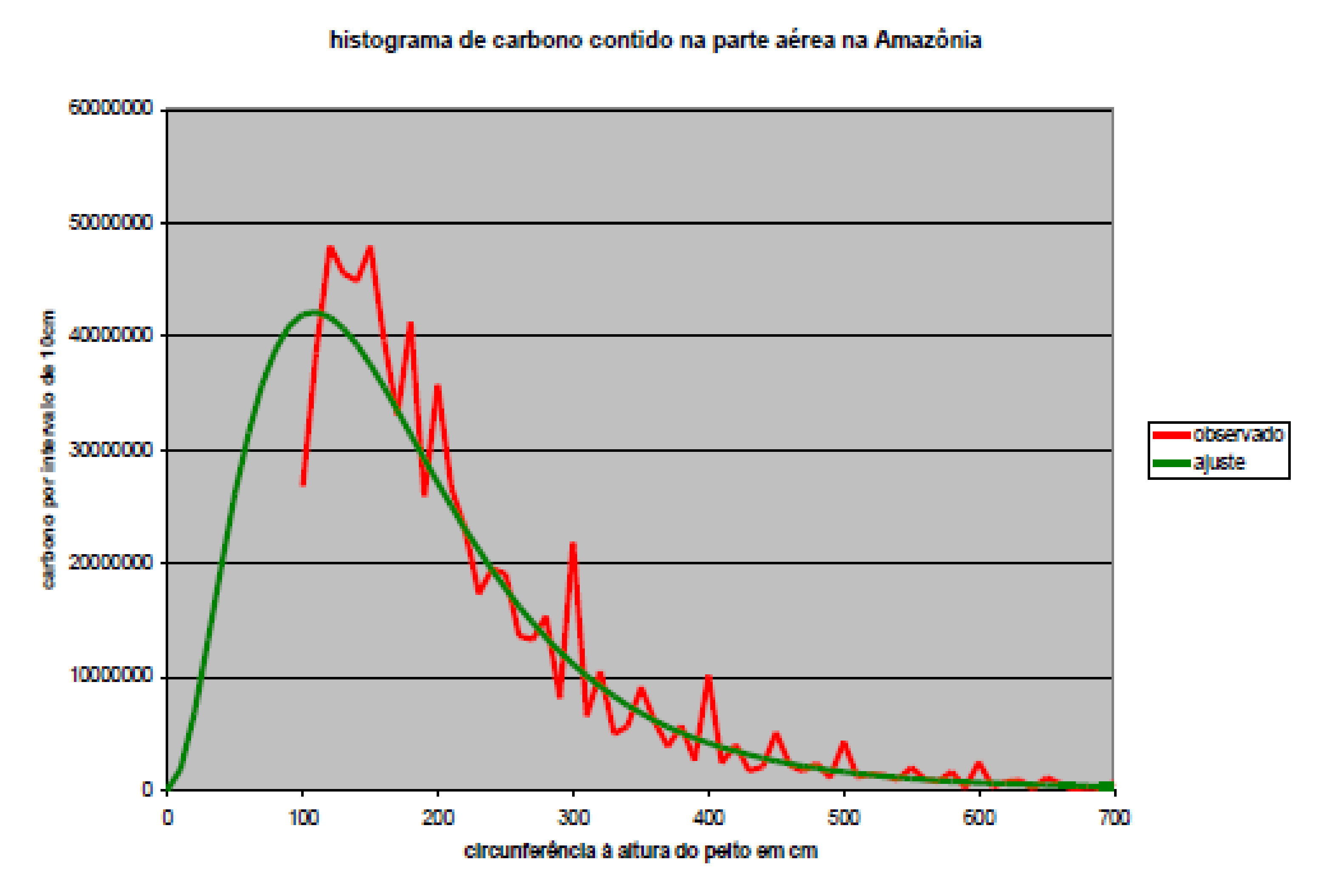
$$C_{(total)} = 1.315698 \times AC_{(CBH > 100\ cm)}$$

where:

$C_{(total)}$ = total carbon stock of all trees in a sample unit; tC/ha

$AC_{(CBH > 100\ cm)}$ = average carbon stock in a sample unit from trees with CBH > 100 cm; tC/ha


histograma de valores de CAP na Amazônia
1000000
100000
10000
1000
100
10
1
0
100
200
300
400
500
600
700
número de árvores por intervalo de 10cm
circunferência à altura do peito em cm
observado
ajuste


histograma de carbono contido na parte aérea na Amazônia
60000000
50000000
40000000
30000000
20000000
10000000
0
carbono por intervalo de 10cm
0
100
200
300
400
500
600
700
circunferência à altura do peito em cm
observado
ajuste

Including Palms and Lianas...

$C_{aboveground}$ = 1.3717 × $AC_{(CBH > 100\ cm}$

[biomass of palms and lianas represent 2.31 and 1.77 per cent of the total aboveground biomass] (Silva, 2007)

where:

$C_{aboveground}$ = the carbon stock in aboveground biomass in a sample unit (from all trees, lianas, palms), tC/ha

$AC_{(CBH > 100\ cm)}$ = average carbon stock in a sample unit from trees with CBH > 100 cm; tC/ha.

Including Belowground Biomass

$$C_{total,\ SU} = 1.9384 \times AC_{(CBH > 100\ cm)}$$

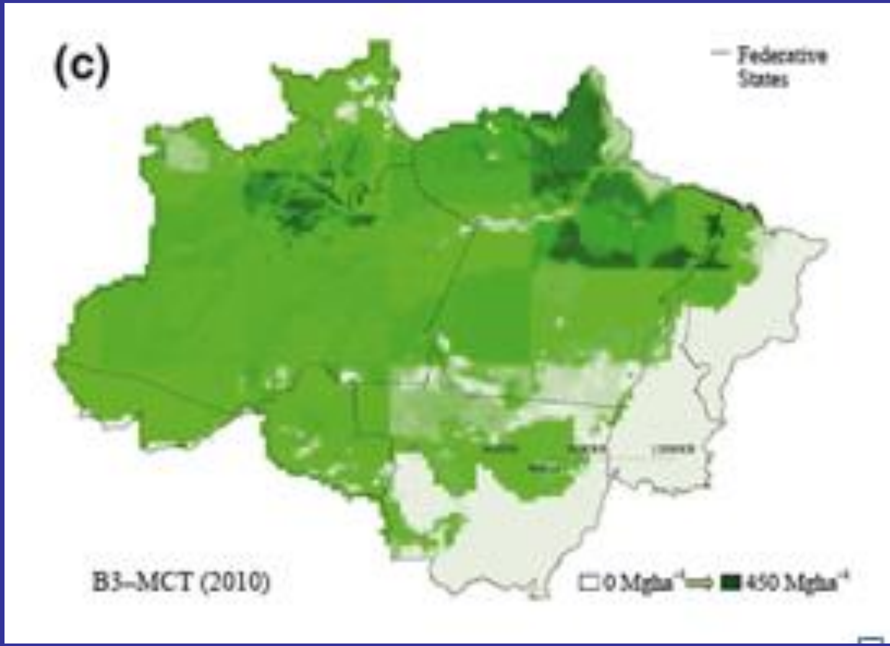
[BLG and litter represent 27.1 per cent of the total biomass (or 37.2 of the aboveground carbon) and 3 per cent of the total ABG] (Silva, 2007)

where:

$C_{total,\ SU}$ = total carbon stock in living biomass (above and below-ground) for all trees, lianas and palms in the sample unit; tC/ha

$AC_{(CBH > 100\ cm)}$ = average carbon stock in a sample unit from trees with CBH > 100 cm; tC/ha.

Biomass Map National GHG Inventory



- Weighted Average Carbon Stock
- 151.6 tC/ha

Sources of Uncertainty

- Single allometric equation
  - Terra firme
- Use of only DBH
- Rules to extrapolate carbon stock to other areas in the Amazonia biome

Global Change Biology (2012), doi: 10.1111/j.1365-2486.2012.02782.x

Modeling the spatial and temporal heterogeneity of deforestation-driven carbon emissions: the INPE-EM framework applied to the Brazilian Amazon

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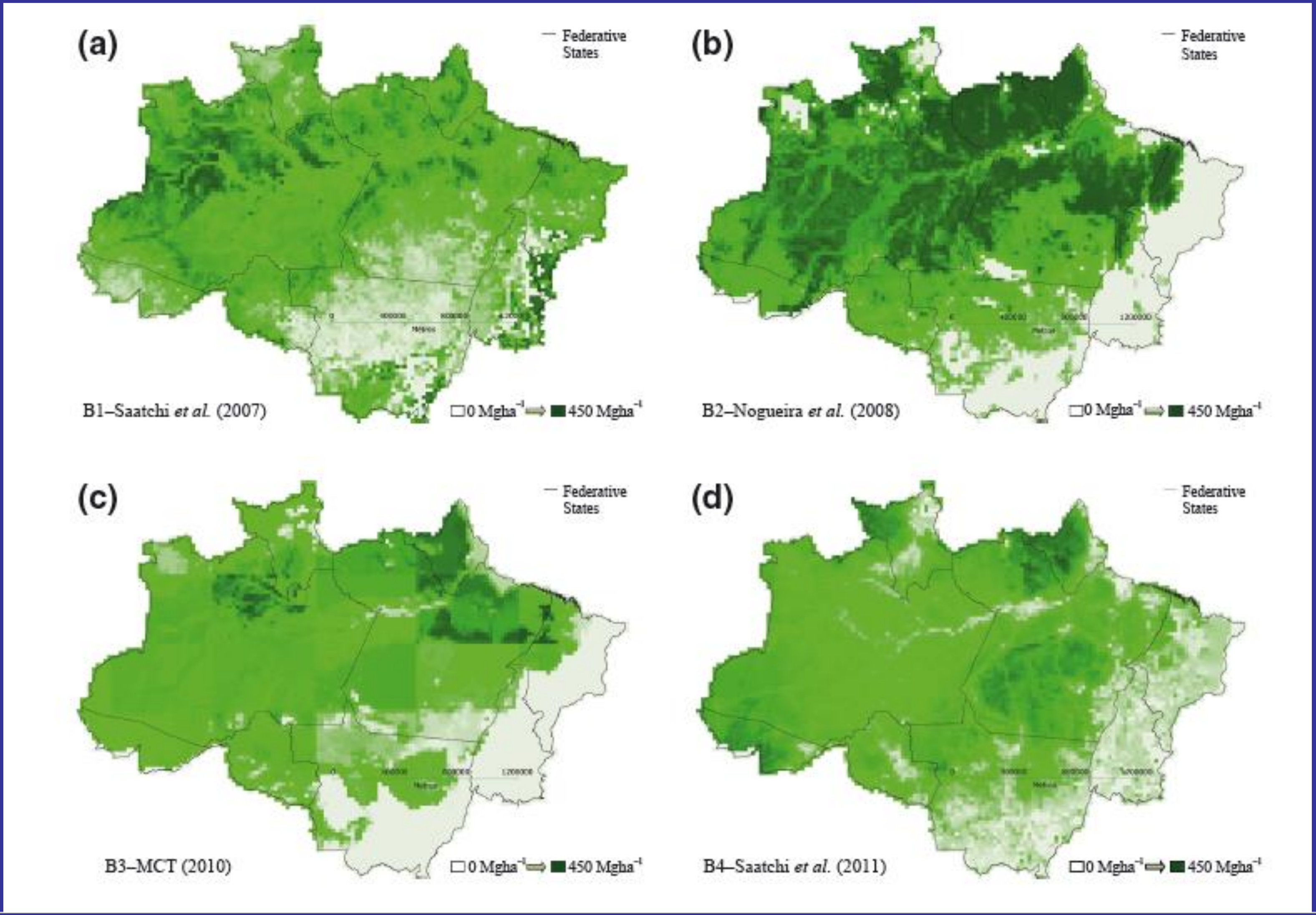
Biomass Maps for Brazilian Amazonia



Carbon Maps for Brazilian Amazonia

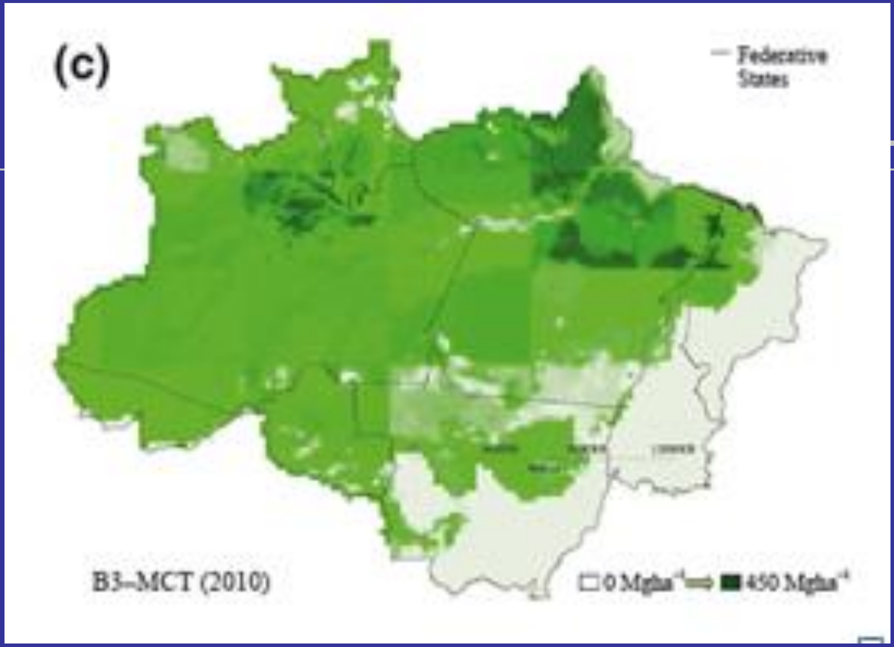
- Largest source of uncertainty regarding carbon emissions from deforestation is the spatial distribution of biomass.

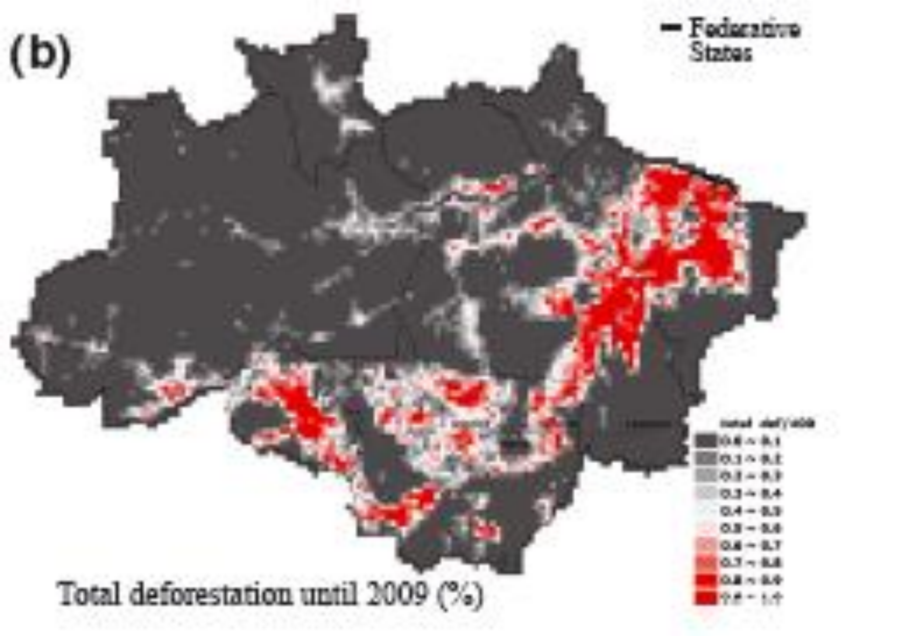
- Differences in emission estimates can be on the order of 20% using our baseline model parameters.

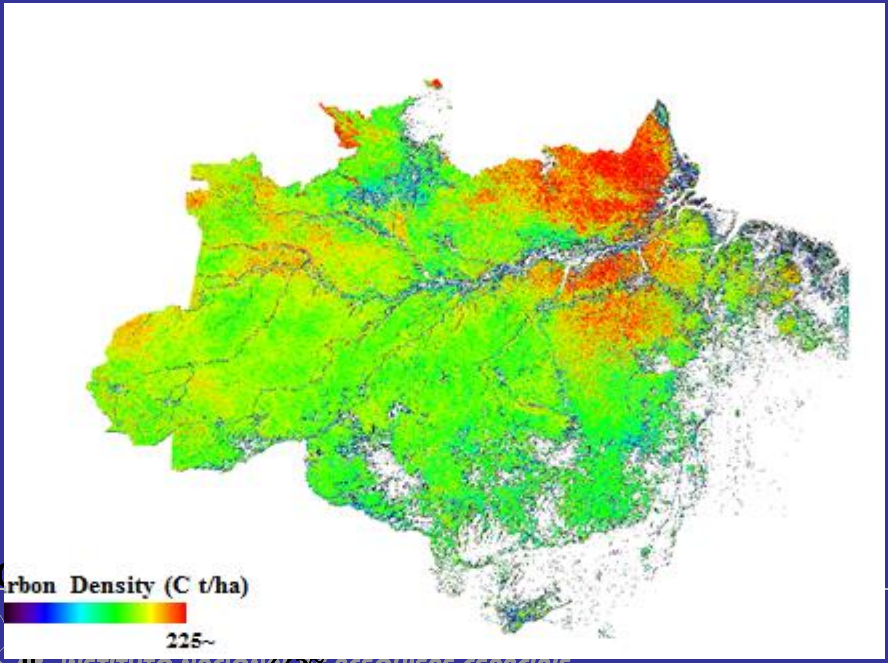
- Estimates based on submodels B1 (Saatch et al., 2007), B3 (MCT, 2010) and B4 (Saatchi et al., 2011a,b) are relatively similar at the regional level, those based on B2 (Nogueira et al., 2008) are significantly higher.

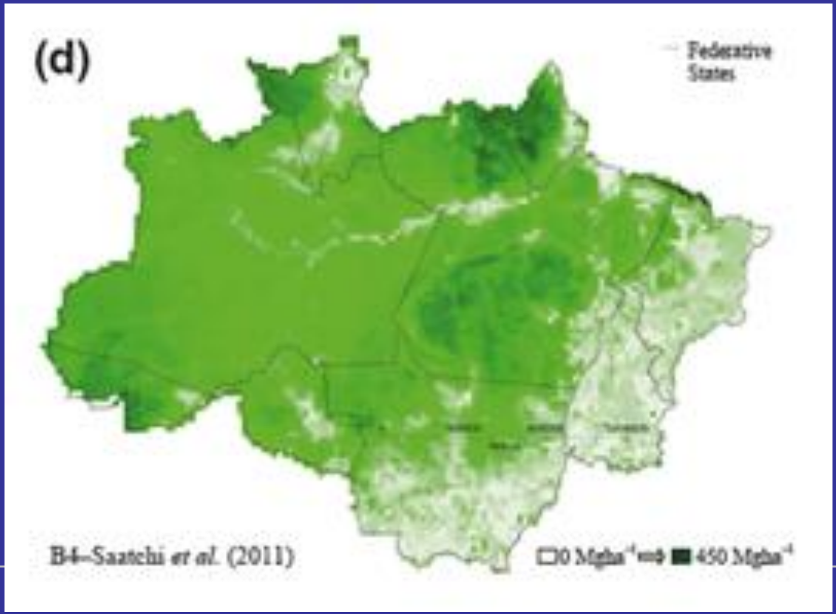
- This difference could be even higher if the same percentage of BGB in relation to AGB in all the submodels.
  Root to shoot ration is 20% in B2, 28% in B3 and 30% in B1–B4.

- The emission estimate differences would increase to 30% as BGB contribution in B2 would be larger.


(c)
Federative States
B3–MCT (2010)
0 Mgha⁻¹ ⟹ 450 Mgha⁻¹


(b)
Federative States
Total deforestation until 2009 (%)


rbon Density (C t/ha)
225~


(d)
Federative States
B4–Saatchi et al. (2011)
0 Mgha⁻¹ ⟹ 450 Mgha⁻¹